

## 8. Claims

While a few of the embodiments of the present invention have been explained, it will be readily apparent to those skilled in the art of the various modifications which can be made to the present invention without departing from the spirit and scope of this application as it is encompassed by the following claims.

What I claim as my invention is:

1. An apparatus for protection of an assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, the apparatus comprising at least:
  - (a) A shaft and shaft mounted components with bores fitted to said shaft;
  - (b) Shaft mounting surfaces that are portions of the shaft surfaces underneath or in close proximity to shaft mounted components;
  - (c) Mounting bore surfaces that are bore surfaces of the shaft mounted components fitted or in close proximity to the shaft;
  - (d) Stress concentrated areas that are portions of the shaft mounting surfaces or portions of the mounting bore surfaces being subject to local high mechanical stresses;
  - (e) Reserves of sacrificial metal being either mounted or deposited, at least partially, to said shaft mounting surfaces and/or to said mounting bore surfaces, said reserves of sacrificial metal being connected electrically to the shaft and to the shaft mounted components, said reserves of sacrificial metal

being anodic to the shaft and to the shaft mounted components therefore providing cathodic protection to both the shaft and the shaft mounted components against corrosion and preventing corrosion related failures in stress concentrated areas.

2. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 1, wherein

- (a) the shaft mounting surfaces have at least a contact free shaft mounting area that is substantially free from contact with the shaft mounted components after completion of the assembly of shaft / shaft mounted components;
- (b) the mounting bore surfaces have at least a contact free mounting bore area that is substantially free from contact with the shaft after completion of the assembly of shaft / shaft mounted components;
- (c) the stress concentrated areas is substantially included in the contact free shaft mounting area or in the contact free mounting bore surfaces.
- (d) the reserves of sacrificial metal are either mounted or deposited to said contact free shaft mounting areas and/or to said contact free mounting bore areas, said reserves of sacrificial metal being connected electrically to the shaft and to the shaft mounted components, said reserves of sacrificial metal being anodic to the shaft and to the shaft mounted components therefore providing cathodic protection to both the shaft and the shaft mounted

components against corrosion and preventing corrosion related failures in the stress concentrated areas.

3. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 1, wherein the reserves of sacrificial metal are zinc or zinc alloy deposited to the shaft mounting surfaces or to the mounting bore surfaces.
4. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 1, wherein the reserves of sacrificial metal are zinc or zinc alloy deposited to the shaft mounting surfaces or to the mounting bore surfaces by inorganic zinc silicate coating, electroplating, thermal spraying or galvanizing.
5. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 1, wherein
  - (a) the shaft mounting surfaces and the mounting bore surfaces are covered by residual mounting lubricant / sealant;
  - (b) the reserves of sacrificial metal are sacrificial metals contained within the residual mounting lubricant / sealant that are deposited to the shaft mounting surfaces and to the mounting bore surfaces.

6. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 1, wherein the reserves of sacrificial metal being either mounted or deposited, at least partially, to said shaft mounting surfaces only or to said mounting bore surfaces only, said reserves of sacrificial metal being connected electrically to the shaft and to the shaft mounted components, said reserves of sacrificial metal being anodic to the shaft and to the shaft mounted components therefore providing cathodic protection to both the shaft mounting surfaces and to the mounting bore surfaces against corrosion and preventing corrosion related failures in stress concentrated areas.
7. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 2, wherein
  - (a) the contact-free shaft mounting areas are portions of shaft fillet and its immediate peripheries or portions of shaft groove and its immediate peripheries that are substantially free from contact with the shaft mounted components after completion of assembly of shaft / shaft mounted components;
  - (b) the contact-free mounting bore areas are portions of the bore surfaces of the shaft mounted components being fitted over or in close proximity to the shaft fillet or the shaft groove.

8. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 2, wherein

- (a) the assembly of shaft / shaft mounted component is an assembly of axle / axle mounted bearing in a rail car wheel set;
- (b) the contact-free shaft mounting areas are portions of axle fillet surfaces, axle groove surfaces, axle journal surfaces or axle dust guard surfaces being substantially free from contact with the axle mounted bearing;
- (c) the contact-free mounting bore areas are portions of bore surfaces of the axle mounted bearing components including backing rings, seal wear rings and spacer rings.

9. An apparatus for protection of internal surfaces of shaft mounted components against corrosion in a machinery or a vehicle, the apparatus comprising at least:

- (a) A shaft and shaft mounted components;
- (b) Internal lubricant encased within the shaft mounted components;
- (c) Contact-free internal areas that are portions of internal surfaces of the shaft mounted components being in contact with internal lubricant and being substantially free from contact with other shaft mounted components;
- (d) Internal reserves of sacrificial metal being either mounted or deposited, at least partially, to said contact-free internal areas, said internal reserves of sacrificial metal being connected electrically to the shaft mounted components, said internal reserves of sacrificial metal being anodic to the

shaft mounted components therefore providing cathodic protection to the shaft mounted components against corrosion.

10. The apparatus for protection of internal surfaces of shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 9, wherein the internal reserves of sacrificial metal are zinc or zinc alloy deposited to the contact-free internal areas.
11. The apparatus for protection of internal surfaces of shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 9, wherein the internal reserves of sacrificial metal are magnesium or magnesium alloys and are mounted to the contact-free internal areas.
12. The apparatus for protection of internal surfaces of shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 9, wherein
  - (a) the assembly of shaft / shaft mounted component is an assembly of axle / axle mounted bearing in a rail car wheel set;
  - (b) the contact-free internal areas are portions of bearing cup surface, bearing spacer ring surface being in contact with internal lubricant and being substantially free from contact with other bearing components.
13. An apparatus for protection of an assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, the apparatus comprising at least:

- (a) A shaft with a varying diameter section thereby defining a maximum sectional diameter and a minimum sectional diameter;
- (b) Two shaft mounted components, each mounted in close proximity to said varying diameter section of said shaft from one end;
- (c) A protective sleeve in resilient material, covering at least partially said varying diameter section of said shaft and sealing at least one of the two joints between said shaft and shaft mounted components; said protective sleeve being mounted to the shaft together with one of the two shaft mounted components and protecting the shaft against corrosion and impact damages.

14. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 13, wherein the protective sleeve is at one end mounted / sealed on one of the shaft mounted components and at the other end mounted to the varying diameter section of the shaft, said the other end of the sleeve having a bore diameter substantially smaller than the maximum sectional diameter and having a body length substantially longer than the varying diameter section of the shaft.

15. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 13, wherein the protective sleeve is at one end mounted / sealed on one of the shaft mounted components and at the other end mounted / sealed on the other shaft mounted component, said sleeve having a body length substantially longer than the varying diameter section of the shaft.

16. The apparatus for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 13, wherein

- (a) the assembly of shaft / shaft mounted components is an assembly of axle / axle mounted bearing / axle mounted wheel in a rail car wheel set;
- (b) the shaft varying diameter section is axle dust guard section or axle groove section located between the axle mounted wheel and the axle mounted bearing.

17. A method for protection of an assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, the method comprising at least:

- (a) Determining contact-free shaft mounting areas that are portions of the shaft surfaces being underneath or in close proximity to shaft mounted components and being substantially free from contact with the shaft mounted components once the assembly of shaft / shaft mounted components is completed;
- (b) Determining contact-free mounting bore areas that are portions of the bore surfaces of the shaft mounted components being fitted or in close proximity to the shaft and being substantially free from contact with the shaft once the assembly of the shaft / the shaft mounted components is completed;

- (c) Determining stress concentrated areas that are subject to local high mechanical stresses and are substantially included within the contact-free shaft mounting surfaces or the contact-free mounting bore surfaces;
- (d) Mounting or depositing, at least partially, reserves of sacrificial metal to said contact-free shaft mounting areas and/or to said contact-free mounting bore areas, said reserves of sacrificial metal being connected electrically to the shaft and the shaft mounted components, said reserves of sacrificial metal being anodic to the shaft and to the shaft mounted components therefore providing cathodic protection to both the shaft and the shaft mounted components against corrosion and preventing corrosion related failures in stress concentrated areas;
- (e) Installing the shaft mounted components by the bores to the shaft.

18. The method for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 17, wherein the reserves of sacrificial metal are zinc or zinc alloy deposited to the contact-free shaft mounting areas or to the contact-free mounting bore areas.

19. The method for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 17, wherein the reserves of sacrificial metal are zinc or zinc deposited to the contact-free shaft mounting areas or to

the contact-free mounting bore areas by inorganic zinc silicate coating, electroplating, thermal spraying or galvanizing.

20. The method for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 17, wherein the reserves of sacrificial metal are deposited to the contact-free shaft mounting areas and to the contact-free mounting bore areas together with mounting lubricant / sealant prior to the assembly of shaft / shaft mounted component.

21. The method for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 17, wherein the reserves of sacrificial metal being either mounted or deposited, at least partially, to said contact free shaft mounting areas only or to said contact free mounting bore areas only, said reserves of sacrificial metal being connected electrically to the shaft and to the shaft mounted components, said reserves of sacrificial metal being anodic to the shaft and to the shaft mounted components therefore providing cathodic protection to both the shaft surfaces and to the bore surfaces against corrosion and preventing corrosion related failures in stress concentrated areas.

22. The method for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 17, wherein

(a) the contact-free shaft mounting areas are portions of shaft fillet and its immediate peripheries or portions of shaft groove and its immediate

peripheries that are substantially free from contact with the shaft mounted components after completion of assembly of shaft / shaft mounted components;

- (b) the contact-free mounting bore areas are portions of the bore surfaces of the shaft mounted components being fitted over or in close proximity to the shaft fillet or the shaft groove.

23. The method for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 17, wherein

- (a) the assembly of shaft / shaft mounted component is an assembly of axle / axle mounted components in a rail car wheel set;
- (b) the contact-free shaft mounting areas are portions of axle fillet surfaces, axle groove surfaces, axle journal surfaces and axle dust guard surfaces being substantially free from contact with the axle mounted components;
- (c) the contact-free mounting bore areas are portions of bore surfaces of axle mounted bearing components including backing rings, seal wear rings and spacer rings.

24. A method for protection of internal surfaces of shaft mounted components against corrosion in a machinery or a vehicle, the apparatus comprising at least:

- (a) Determining contact-free internal areas that are portions of internal surfaces of the shaft mounted components being in contact with internal lubricant and

being substantially free from contact with other shaft mounted components  
once the shaft mounted components are assembled to the shaft;

- (b) Mounting or depositing internal reserves of sacrificial metal, at least partially,  
to said contact-free internal areas, said internal reserves of sacrificial metal  
being connected electrically to the shaft mounted components, said internal  
reserves of sacrificial metal being anodic to the shaft mounted components  
therefore providing cathodic protection to the shaft mounted components  
against corrosion;
- (c) Add internal lubricant to the internal surface of shaft mounted components;
- (d) Installing the shaft mounted components to the shaft.

25. The method for protection of internal surfaces of shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 24, wherein the internal reserves of sacrificial metal are zinc or zinc alloy deposited to the contact-free internal areas.

26. The method for protection of internal surfaces of shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 24, wherein the internal reserves of sacrificial metal are magnesium or magnesium alloys and are mounted to the contact-free internal areas.

27. The method for protection of internal surfaces of shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 24, wherein

- (a) the assembly of shaft / shaft mounted component is an assembly of axle / axle mounted bearing in a rail car wheel set;
- (c) Contact-free internal areas are portions of bearing cup surface, bearing spacer ring surface being in contact with internal lubricant and being substantially free from contact with other bearing components.

28. A method for protection of an assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, the method comprising at least:

- (a) Determining a maximum sectional diameter and a minimum sectional diameter in a varying diameter section of said shaft;
- (b) Mounting two shaft mounted components, each being in close proximity to said varying diameter section of said shaft from one end;
- (c) Mounting a protective sleeve in resilient material to the shaft, covering at least partially said varying diameter section of said shaft and sealing at least one of the two joints between said shaft and shaft mounted components; said protective sleeve being mounted to the shaft together with one of the two shaft mounted components and protecting the shaft against corrosion and impact damages.

29. The method for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 28, wherein the protective sleeve is at one end mounted / sealed on one of the shaft mounted components and at the other end mounted to the varying diameter section of the shaft, said the other end of the

sleeve having a bore diameter substantially smaller than the maximum sectional diameter and having a body length substantially longer than the varying diameter section of the shaft.

30. The method for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 28, wherein the protective sleeve is at one end mounted / sealed on one of the shaft mounted components and at the other end mounted / sealed on the other shaft mounted component, said sleeve having a body length substantially longer than the varying diameter section of the shaft.

31. The method for protection of the assembly of shaft / shaft mounted components against corrosion in a machinery or a vehicle, as recited in Claim 28, wherein

- (a) the assembly of shaft / shaft mounted components is an assembly of axle / axle mounted bearing / axle mounted wheel in a rail car wheel set;
- (b) the shaft varying diameter section is the axle dust guard section or axle groove section located between axle mounted wheel and axle mounted bearing.